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Site Evaluation for Application of Fuel Cell Technology

Naval Oceanographic Office, John C. Stennis Space Center, MS

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Construction Engineering
Research Laboratory

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Foreword

In fiscal years 93 and 94, Congress provided funds for natural gas utilization equipment, part of which was specifically designated for procurement of natural gas fuel cells for power generation at military installations. The purchase, installation, and ongoing monitoring of 30 fuel cells provided by these appropriations has come to be known as the "DOD Fuel Cell Demonstration Program." Additional funding was provided by: the Office of the Deputy Under Secretary of Defense for Industrial Affairs & Installations, ODUSD (IA&I)/HE&E; the Strategic Environmental Research & Development Program (SERDP); the Assistant Chief of Staff for Installation Management (ACSIM); the U.S. Army Center for Public Works (CPW); the Naval Facilities Engineering Service Center (NFESC); and Headquarters (HQ), Air Force Civil Engineer Support Agency (AFCESA).

This report documents work done at the Naval Oceanographic Office, John C. Stennis Space Center, MS. Special thanks is owed to the John C. Stennis Space Center point of contact (POC), Robert Heitzmann, for providing investigators with access to needed information for this work. The work was performed by the Energy Branch (CF-E), of the Facilities Division (CF), Construction Engineering Research Laboratory (CERL). The CERL Principal Investigator was Michael J. Binder. Part of this work was performed by Science Applications International Corp. (SAIC), under Contract DACA88-94-D-0020, task orders 0002, 0006, 0007, 0010, and 0012. The technical editor was William J. Wolfe, Information Technology Laboratory. Larry M. Windingland is Chief, CEERD-CF-E, and L. Michael Golish is Chief, CEERD-CF. The associated Technical Director was Gary W. Schanche. The Acting Director of CERL is William D. Goran.

CERL is an element of the U.S. Army Engineer Research and Development Center (ERDC), U.S. Army Corps of Engineers. The Director of ERDC is Dr. James R. Houston and the Commander is COL James S. Weller.

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Background

Fuel cells generate electricity through an electrochemical process that combines hydrogen and oxygen to generate electricity. Fuel cells are an environmentally clean, quiet, and a highly efficient method for generating electricity and heat from natural gas and other fuels. Air emissions from fuel cells are so low that several Air Quality Management Districts in the United States have exempted fuel cells from requiring operating permits. Today's natural gas-fueled fuel cell power plants operate at electrical conversion efficiencies of 40 to 50 percent; these efficiencies are predicted to climb to 50 to 60 percent in the near future. In fact, if the heat from the fuel cell process is used in a cogeneration system, efficiencies can exceed 85 percent. By comparison, current conventional coal-based technologies operate at efficiencies of 33 to 35 percent.

Phosphoric Acid Fuel Cells (PAFCs) are in the initial stages of commercialization. While PAFCs are not now economically competitive with other more conventional energy production technologies, current cost projections predict that PAFC systems will become economically competitive within the next few years as market demand increases.

Fuel cell technology has been found suitable for a growing number of applications. The National Aeronautics and Space Administration (NASA) has used fuel cells for many years as the primary power source for space missions and currently uses fuel cells in the Space Shuttle program. Private corporations have recently been working on various approaches for developing fuel cells for stationary applications in the utility, industrial, and commercial markets. Researchers at the Construction Engineering Research Laboratory (CERL) have actively participated in the development and application of advanced fuel cell technology since fiscal year 1993 (FY93), and have successfully executed several research and demonstration work units with a total funding of approximately $55M.

As of 30 November 1997 commercially available fuel cell power plants and their thermal interfaces have been installed at DOD locations. CERL managed 29 of these installations. As a consequence, the Department of Defense (DOD) is the owner of the largest fleet of fuel cells worldwide. CERL researchers have developed a methodology for selecting and evaluating application sites, have supervised the design and installation of fuel cells, and have actively monitored the operation and maintenance of fuel cells, and compiled "lessons learned" for feedback to manufacturers. This accumulated expertise and experience has enabled CERL to lead in the advancement of fuel cell technology through major efforts such as the DOD Fuel Cell Demonstration Program, the Climate Change Fuel Cell Program, research and development efforts aimed at fuel cell product improvement and cost reduction, and conferences and symposiums dedicated to the advancement of fuel cell technology and commercialization.

This report presents an overview of the information collected at the Naval Oceanographic Office, John C. Stennis Space Center, MS along with a conceptual fuel cell installation layout and description of potential benefits the technology can provide at that location. Similar summaries of the site evaluation surveys for the remaining 28 sites where CERL has managed and continues to monitor fuel cell installation and operation are available in the companion volumes to this report (see Table 1).

Objective

The objective of this work was to evaluate Naval Oceanographic Office as a potential location for a fuel cell application.

Approach

On 2 and 3 July 1996, CERL and SAIC representatives visited the Naval Oceanographic Office at Stennis Space Center (the site) to investigate it as a potential location for a 200 kW fuel cell. This report presents an overview of information collected at the site along with a conceptual fuel cell installation layout and description of potential benefits. The Appendix to this report contains a copy of the site evaluation form filled out at the site.

Table 1. Companion ERDC/CERL site evaluation reports.

Location	Report No.
Fort Bliss, TX	ERDC/CERL TR-00/DRAFT
Fort Eustis, VA	ERDC/CERL TR-00/DRAFT
Fort Huachuca, AZ	ERDC/CERL TR-00/15
Fort Richardson, AK	ERDC/CERL TR-00/DRAFT
Picatinny Arsenal, NJ	ERDC/CERL TR-00/DRAFT
Pine Bluff Arsenal, AR	ERDC/CERL TR-00/DRAFT
U.S. Army Soldier Systems Command, Natick, MA	ERDC/CERL TR-00/DRAFT
U.S. Military Academy, West Point, NY	ERDC/CERL TR-00/DRAFT
Watervliet Arsenal, Albany, NY	ERDC/CERL TR-00/DRAFT
911th Airlift Wing, Pittsburgh, PA	ERDC/CERL TR-00/DRAFT
934th Airlift Wing, Minneapolis, MN	ERDC/CERL TR-00/DRAFT
Barksdale Air Force Base (AFB), LA	ERDC/CERL TR-00/DRAFT
Davis-Monthan Air Force Base (AFB), AZ	ERDC/CERL TR-00/DRAFT
Edwards Air Force Base (AFB), CA	ERDC/CERL TR-00/DRAFT
Kirtland Air Force Base (AFB), NM	ERDC/CERL TR-00/DRAFT
Laughlin Air Force Base (AFB), TX	ERDC/CERL TR-00/DRAFT
Little Rock Air Force Base (AFB), AR	ERDC/CERL TR-00/DRAFT
Nellis Air Force Base (AFB), NV	ERDC/CERL TR-00/DRAFT
Westover Air Force Base (AFB), MA	ERDC/CERL TR-00/DRAFT
Construction Battalion Center (CBC) Port Hueneme, CA	ERDC/CERL TR-00/DRAFT
Naval Air Station Fallon, NV	ERDC/CERL TR-00/DRAFT
Naval Education Training Center, Newport, RI	ERDC/CERL TR-00/DRAFT
Naval Hospital • Marine Corps Base Camp Pendleton, CA	ERDC/CERL TR-00/DRAFT
Naval Hospital • Naval Air Station Jacksonville, FL	ERDC/CERL TR-00/DRAFT
Naval Oceanographic Office, John C. Stennis Space Center, MS	ERDC/CERL TR-01-3
Subase New London, Groton, CT	ERDC/CERL TR-00/DRAFT
U.S. Naval Academy, Annapolis, MD	ERDC/CERL TR-00/DRAFT
National Defense Center for Environmental Excellence, (NDCEE) Johnstown, PA	ERDC/CERL TR-00/DRAFT
Naval Hospital • Marine Corps Air Ground Combat Center (MCAGCC) Twentynine Palms, CA	ERDC/CERL TR-00/DRAFT

Units of Weight and Measure

U.S. standard units of measure are used throughout this report. A table of conversion factors for Standard International (SI) units is provided below.

1 ft	=	0.305 m
1 mile	=	1.61 km
1 acre	=	0.405 ha
1 gal	=	3.78 L
°F	=	°C (X 1.8) + 32

2 Site Description

Stennis Space Center is located approximately 35 miles west of Gulfport, MS, near the Louisiana border. It is one of four space flight centers operated by NASA. Stennis Space Center's primary mission is to test rocket propulsion engines, systems, and vehicles. It currently develops, tests, and certifies the Space Shuttle's main engine. Personnel at Stennis Space Center are involved in research and technology projects including commercialization of remote sensing technology, earth sciences research, etc. The space center is also home to 22 resident agencies including the Naval Oceanographic Office. ASHRAE design temperatures at the site are 22 °F for winter and 92 °F for summer. Extreme temperatures are 9 and 104 °F.

The Naval Oceanographic Office (NAVOCEANO) is a primary tenant at Stennis Space Center and the focus of this site evaluation. NAVOCEANO provides oceanographic products, data, and services worldwide to DOD and oceanographic related organizations. It has an extensive data bank used for producing a wide range of charts. Survey data is collected using ships, aircraft, remotely operated vehicles, satellites, buoys, and mobile weather stations. NAVOCEANO has supercomputers that can process large volumes of data quickly and provide up-to-the-minute information to support ocean-based operations. The Computer Programming Operations Center (building 1003) was the site identified by NAVOCEANO as the most desirable location for a 200 kW fuel cell.

Building 1003 houses a computer operations center, library, and lab space. Space conditioning is required 24 hours/day, 7 days per week throughout the year. The building's space conditioning requirements are supplied by a hot water boiler and two centrifugal chillers. The boiler distributes hot water throughout the building to individual fan coil units. In the summer, the boiler is used for reheat humidity control.

Site Layout

Figure 1 presents the layout of building 1003 at the Stennis Space Center. The building is divided into four main areas. A library occupies the southernmost area and the remaining three areas belong to computer operations.

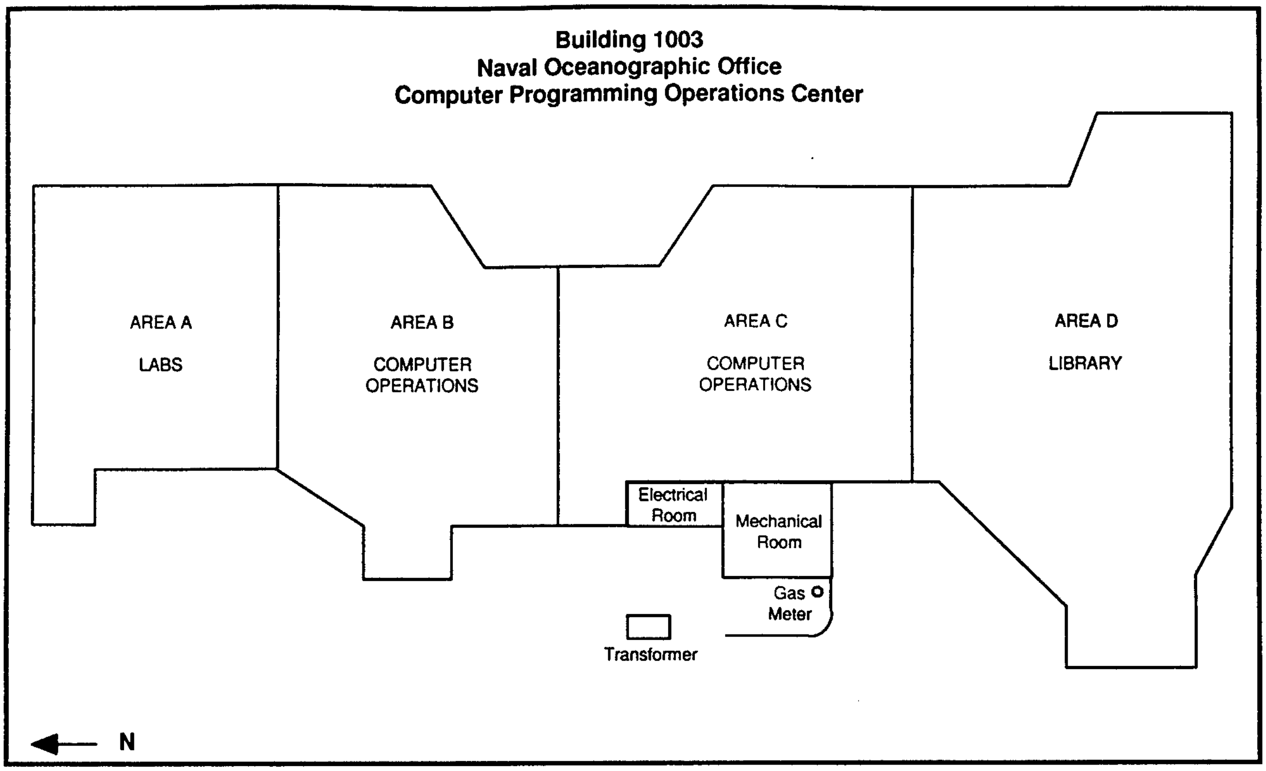

Figure 1. Building 1003 layout.

The mechanical and electrical rooms are located on the west side of the building. The building's main gas meter is located just outside of the mechanical room. There is a limited open area just outside the electrical room. The east side (back) of the building is completely open.

Electrical System

The site distributes electricity at 13,800 V. There is a 480/13,800 V, 1500 kVA transformer located at Building 1003. There are two 480V electric panels rated at 500 and 1200 amps inside the electrical room. There is a spare 480 V breaker where the fuel cell could be interfaced with the building.

Steam/Hot Water System

The only domestic hot water (DHW) used in the building is for the bathrooms that are supplied by individual electric hot water heaters.

Space Heating System

There is a 1.4 MBtu (million Btu) Kewanee Boiler Co. boiler located inside the mechanical room that provides hot water for space heating. The boiler operates on natural gas. There are three circulating pumps, two rated at 185 gpm and one rated at 145 gpm, which circulate 150 to 180 °F (depending on outdoor temperature) hot water throughout the building. Fan coil units are located throughout the building for space heating to individual areas.

Space Cooling System

Two 135 ton McQuay centrifugal chillers are located in the mechanical room. The chillers operate continuously throughout the year to cool the computer areas. Only one chiller runs during the winter, but both chillers operate during the summer. Chilled water is distributed to individual fan coil units throughout the building. Figure 2 presents the layout of the electrical and mechanical rooms.

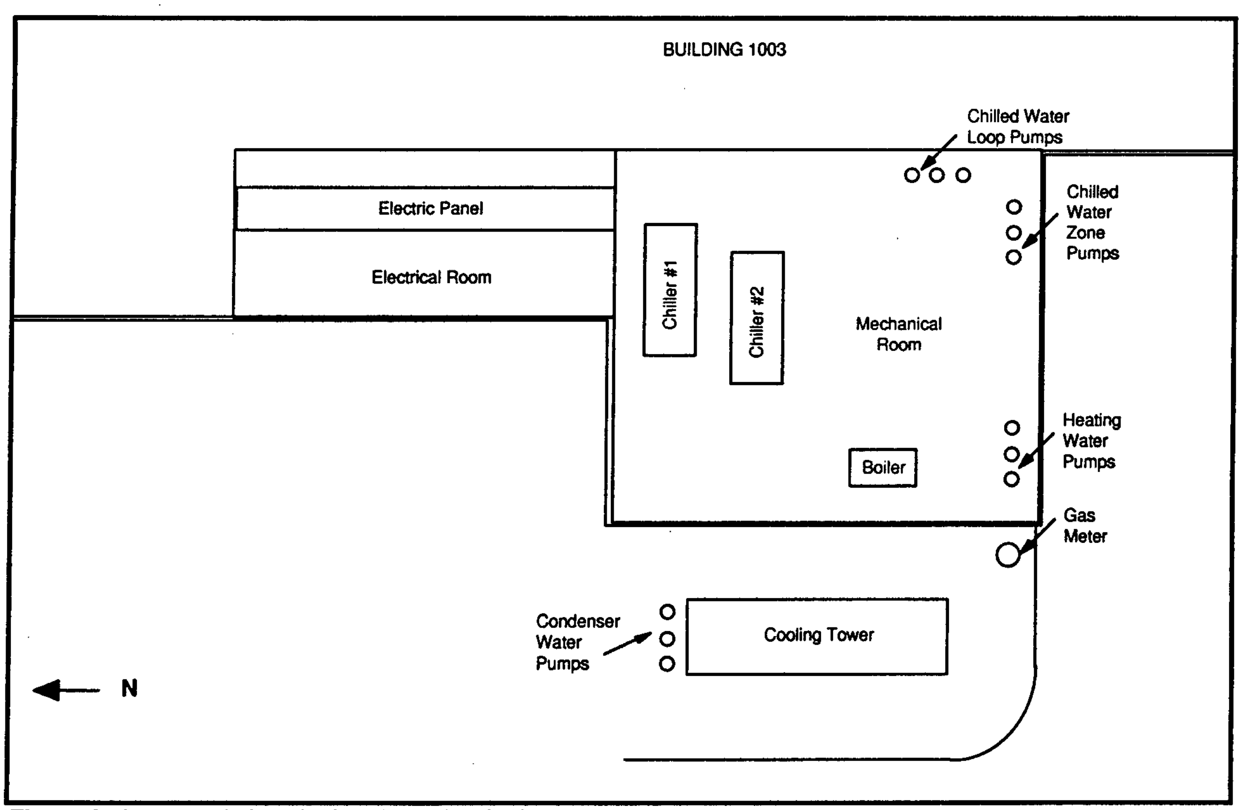

Figure 2. Layout of electrical and mechanical rooms.

Fuel Cell Location

The two potential locations for the fuel cell are the grassy area at the entrance of the electrical and mechanical rooms and the back of the building. Figure 3 identifies these areas as Location Option #1 and Location Option #2, respectively. Location Option #1 is closest to the electrical room, mechanical interfaces, and gas line. During the site visit, base personnel indicated that this area may be required for the location of mechanical equipment needed for a second story addition to a nearby building (Building 1000). For this reason, it was considered unlikely that site approval for Location Option #1 could be obtained from pertinent authorities. As a result, the proposed location for the fuel cell is the back of the building, opposite the mechanical room. This large, open area is flat and easily accessible. However, electrical, thermal, and gas piping runs will be longer than for Location Option #1.

The fuel cell should be oriented in a north-south direction with the thermal outlet side facing the building (Figure 4). The cooling module should be positioned behind the fuel cell and the N_2 bottles located up against the wall.

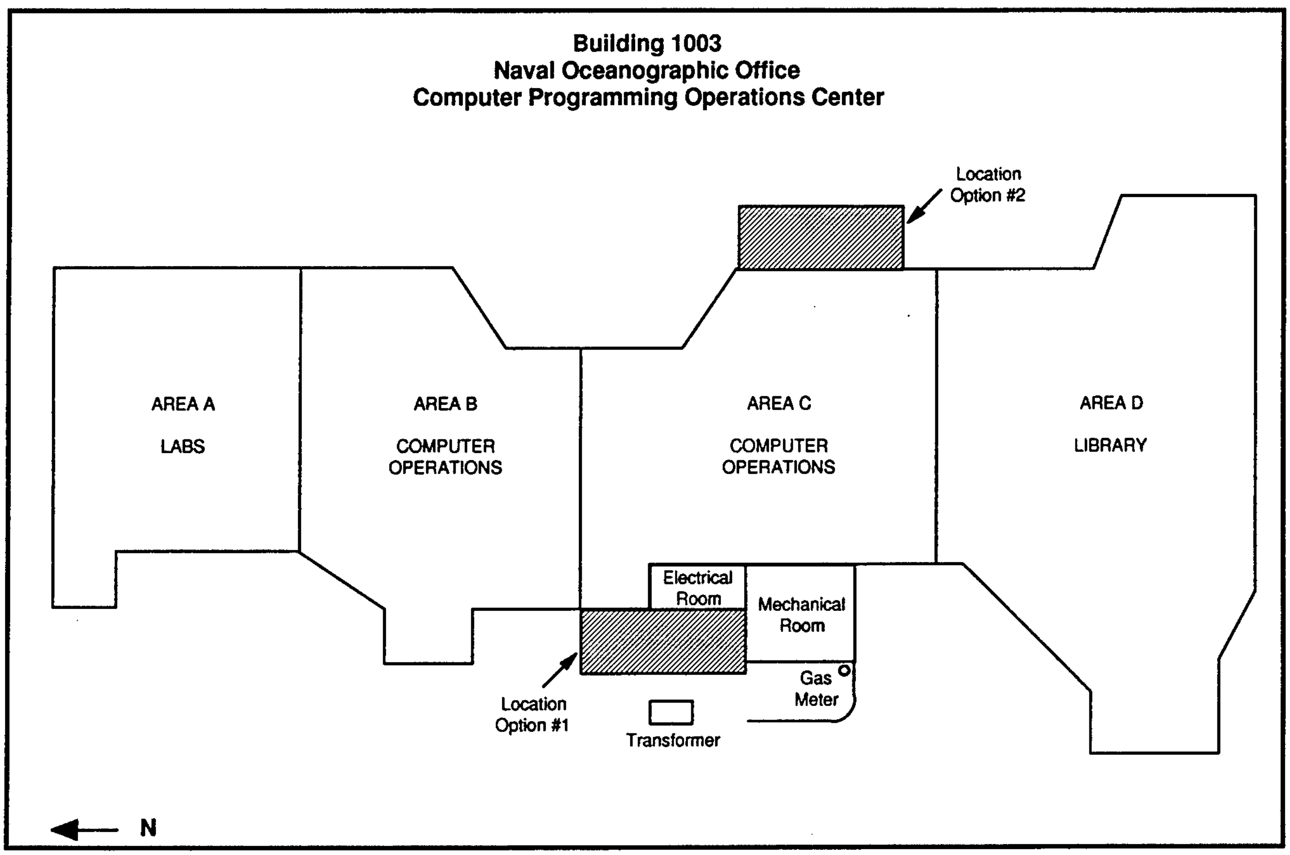

Figure 3. Building 1003 fuel cell location options.

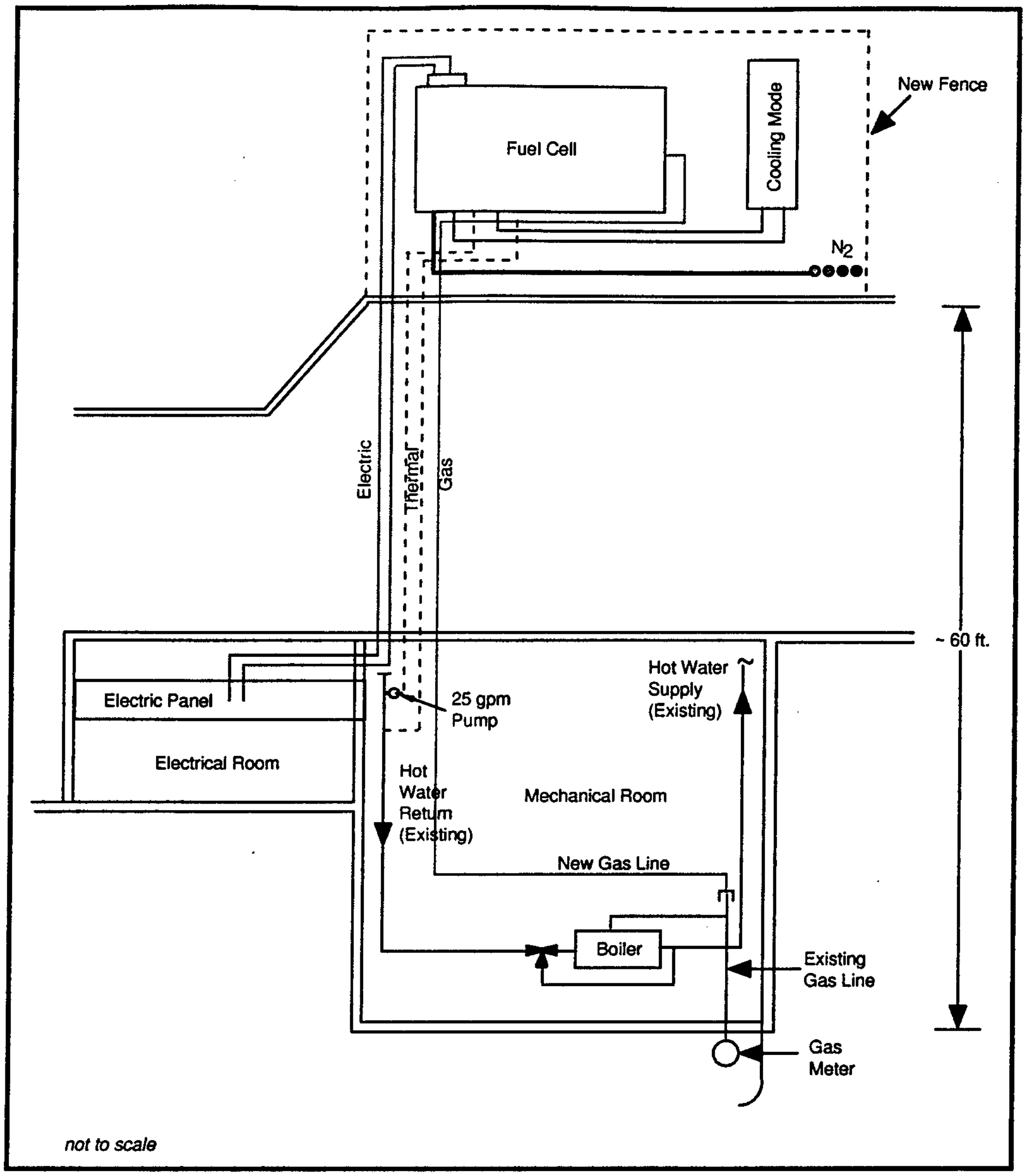

Figure 4. Fuel cell building interface diagram.

All interfaces will have to be run across the building in the suspended ceiling space. The building is approximately 60 ft wide at this proposed location. Site personnel indicated that there is a hallway that crosses the building between the proposed fuel cell location and the mechanical room. Running conduit and piping through the ceiling space above the hallway would help reduce the impact of construction and minimize disturbances to the building occupants. The cooling module piping would have a piping run of approximately 25 ft.

Fuel Cell Interfaces

Building 1003 uses 480 volt, three phase, four wire electricity through a 480/13,800 volt 1,500 kVA transformer. The fuel cell output should be connected to the existing Square D 480 volt, 1,200 amp electrical panel in the electrical room. When the building load drops below 200 kW, the excess electricity will flow through the 1,500 kVA transformer into the base grid.

Site personnel requested that the fuel cell be configured to provide backup power for cases of loss of electrical service from the grid. It is the responsibility of the site personnel to identify a 200 kW electrical load to be dedicated to the backup service and wire this load to the panel for the fuel cell electrical interface. Site personnel requested that the backup load include a chiller. To operate the chiller would require the operation of the cooling tower fan, a condenser water pump, a chilled water pump, and the chiller. SAIC contacted ONSI Corporation to determine the maximum motor load that can be dedicated to the fuel cell and ONSI indicated that the maximum has not yet been determined. However, it is not likely that the fuel cell would be capable of supporting the electrical service required to start each of these motors following a power failure. This matter should be investigated further during the design phase of this installation.

The thermal output from the fuel cell should be interfaced with the hydronic space conditioning system (space heating and air conditioning reheat). The flow rate of the hot water system is currently 330 gpm. The leaving water set point from the boiler is controlled by a Landis & Gyr energy management and control system, which has an algorithm to provide warmer water at lower outdoor ambient air conditions. The proposed thermal interface is to take 25 gpm of water from the return line, heat it in the fuel cell, and return it to the return line prior to the boiler (Figure 5). The 25 gpm circulating pump should run whenever the fuel cell is operating and the return mix temperature is below the set point.

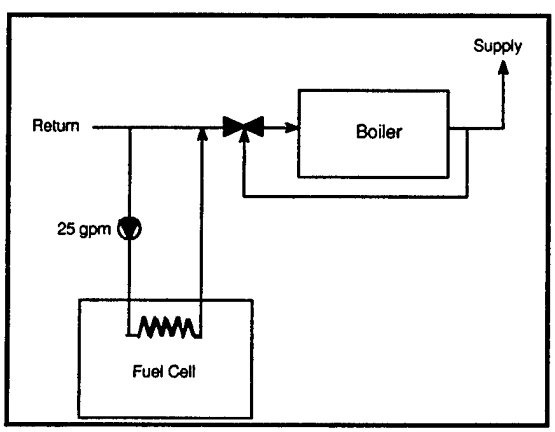

Figure 5. Fuel cell thermal interface.

Table 2. Building 1003 gas load data.

Date	MCF	KBtu/hr*
Jun-95	146.6	157
Jul-95	145.1	151
Aug-95	121.4	126
Sep-95	170.6	183
Oct-95	196.3	204
Nov-95	225.6	242
Dec-95	255.1	265
Jan-96	299.6	311
Feb-96	218.4	251
Mar-96	275.6	286
Apr-96	221.8	238
May-96	198.7	206
Tot/Avg	2,475	218

* kBtu/hr = (MCF * 1030 kBtu/MCF * 75% Boiler Efficiency) / hr/period

The building thermal load was estimated using existing gas consumption records and assuming a boiler efficiency of 75 percent. The only gas load for the building is the boiler. Table 2 lists the gas load data.

The maximum average thermal load occurred in January at 311 kBtu/hr when the boiler was used mostly for space heating. During the space heating months (November-April), the average hot water load is 266 kBtu/hr. The minimum occurred in August at 126 kBtu/hr when the boiler was used for reheat on the air conditioning system. During the air conditioning reheat months of (May-October), the average hot water load was 171 kBtu/hr.

Heat recovery operation during space heating is estimated as follows. The heating loop temperature differential for a 266 kBtu/hr load at 330 gpm is 1.61 °F:

1.61 °F = 266,000 Btu/hr / (330 gpm * 60 min/hr * 8.33 lb/gal * 1.0 Btu/lb °F)

Assuming that the design supply water temperature for heating is 180 °F, the return building temperature would be 178.4 °F. This temperature appears to be too high for the standard fuel cell heat exchanger and would require the optional high temperature heat exchanger. Heat recovery operation during reheat is estimated as follows. The heating loop temperature differential for a 171 kBtu/hr load at 330 gpm is 1.0 °F:

1.0 °F = (171,000 Btu/hr) / (330 gpm * 60 min/hr * 8.33 lb/gal * 1.0 Btu/lb °F)

Assuming that the design supply water temperature for heating is 150 °F, the return building temperature would be 149 °F. Under these conditions, ONSI literature indicates that the fuel cell would be capable of providing approximately 300 kBtu/hr at 175 °F. Thus, the fuel cell could supply all of the reheat requirement at this site.

There are two potential thermal interfaces for Building 1003. The low grade heat exchanger would be interfaced to the hydronic space conditioning system. This would not require the high grade heat exchanger option, but only 6 months of fuel cell thermal recovery for reheat space conditioning would be obtained. The second alternative would be to interface the high grade heat exchanger option for a full 12 months of fuel cell thermal utilization. Under either scenario, only one thermal loop would be interfaced, i.e., either the high grade or low grade heat exchanger would be used, not both.

The estimated total fuel cell thermal use for this application without a high grade heat exchanger option (i.e., providing reheat only for 6 months) would be 749 MBtu/year at a thermal utilization of 12 percent.

Standard Heat Exchanger Thermal Use:

749 MBtu = 0.171 MBtu/hr * 4,380 hrs/yr

Standard Heat Exchanger Thermal Utilization (percentage of fuel cell heat used):

12% = 749 MBtu / (0.700 MBtu/hr * 8,760 hrs)

The estimated total fuel cell thermal use for the high grade heat exchanger option (serving both the space heating and reheating requirements for 12 months) would be 1,914 MBtu/year at a thermal utilization of 31 percent, or:

High Grade Heat Exchanger Thermal Use:

1,914 MBtu = (0.266 MBtu/hr * 4,380 hrs/yr) + (0.171 MBtu/hr * 4,380 hrs/yr)

High Grade Heat Exchanger Thermal Utilization (percentage of fuel cell heat used):

31% = 1,914 MBtu / (0.700 MBtu/hr * 8,760 hrs)

Economic Analysis

Stennis Space Center purchases electricity from Mississippi Power Company under rate schedule LGS-23. NAVOCEANO is billed for its electricity from the base Public Works Department. Table 3 gives the Building 1003 electricity consumption and costs for the June 1995 to May 1996 time period. The average rate paid by NAVOCEANO during this period was 4.34 cents/kWh.

Stennis Space Center purchases natural gas on the spot market through United Gas Company. NAVOCEANO then purchases its natural gas from base Public Works. Table 4 presents natural gas consumption and costs for Building 1003 for the June 1995 to May 1996 time period. The average rate during this period was $2.16/MCF. Total annual natural gas costs for Building 1003 were $5,351.

Electric savings from the fuel cell were calculated based on the fuel cell operating 90 percent of the year (1,576,800 kWh). Electricity savings of $68,433 were calculated as:

$68,433 = 1,576,800 kWh * $0.0434/kWh

It was previously estimated that Building 1003 could use 749 MBtu/year of the fuel cell's thermal energy for reheat, which is a thermal utilization of 12 percent. Assuming a 75 percent displaced boiler efficiency and a 90 percent fuel cell capacity factor, the fuel cell would displace 899 MBtu at the boiler plant:

899 MBtu = (749 MBtu * 90% capacity factor) / 75% boiler eff.

Table 3. Building 1003 electricity consumption and costs.

Date	KWh	Avg. KW	Total Cost	$/KWh
Jun-95	220,608	306	$9,751	$0.0442
Jul-95	211,392	284	$9,301	$0.0440
Aug-95	216,576	291	$9,464	$0.0437
Sep-95	207,360	288	$9,062	$0.0437
Oct-95	176,832	238	$7,904	$0.0447
Nov-95	144,000	200	$6,422	$0.0446
Dec-95	144,000	194	$6,264	$0.0435
Jan-96	174,528	235	$7,452	$0.0427
Feb-96	164,160	244	$6,928	$0.0422
Mar-96	147,456	198	$6,429	$0.0436
Apr-96	220,608	306	$9,199	$0.0417
May-96	112,896	152	$4,792	$0.0425
Tot/Avg	2,140,416	244	$92,970	$0.0434

Table 4. Building 1003 natural gas consumption and costs.

Date	Total MCF	KBtu/Hour	Cost	$/MCF
Jun-95	146.6	157	$164	$1.12
Jul-95	145.1	151	$167	$1.15
Aug-95	121.4	126	$251	$2.07
Sep-95	170.6	183	$425	$2.49
Oct-95	196.3	204	$418	$2.13
Nov-95	225.6	242	$408	$1.81
Dec-95	255.1	265	$717	$2.81
Jan-96	299.6	311	$806	$2.69
Feb-96	218.4	251	$330	$1.51
Mar-96	275.6	286	$650	$2.36
Apr-96	221.8	238	$472	$2.13
May-96	198.7	206	$542	$2.73
Tot/Avg	2,475	218	$5,351	$2.16

If the high grade heat exchanger option is specified, Building 1003 could use 1,914 MBtu/year of the fuel cell's thermal energy for both space heating and reheat, which is a thermal utilization of 31 percent. Assuming a 75 percent displaced boiler efficiency and a 90 percent fuel cell capacity factor, the fuel cell would displace 2,297 MBtu in the first year:

2,297 MBtu = (1,914 MBtu * 90% capacity factor) / 75% boiler eff.

The fuel cell would be displacing natural gas at a rate of $2.16/MCF. The thermal savings from the fuel cell would be, for the Low Grade Heat Exchanger:

$1,885 = 899 MBtu * ($2.16/MCF / 1.03 MBtu/MCF)

and for the High Grade Heat Exchanger:

$4,817 = 2,297 MBtu * ($2.16/MCF / 1.03 MBtu/MCF).

The fuel cell will consume 14,949 MBtu per year based on an electrical efficiency of 36 percent HHV (higher heating value). Input natural gas cost for the fuel cell is $31,349:

$31,349= 14,949 MBtu * ($2.16/MCF / 1.03 MBtu/MCF)

Table 5 presents estimated savings for the fuel cell using the low grade heat exchanger and the high grade heat exchanger. Net savings for the low grade heat exchanger case (12 percent thermal utilization) were calculated at $38,969. For the high grade heat exchanger, net savings of $42,436 were estimated. There is a $3,467 difference in thermal savings between the low and high grade heat exchanger options. Table 5 also lists savings for 100 percent thermal utilization if the site could use all the fuel cell output.

The analysis is a general overview of the potential savings from the fuel cell. For the first 56 months (dependent on remaining program funds after fuel cell options are selected for each Service branch), ONSI will be responsible for the fuel cell maintenance. Maintenance costs are not reflected in this analysis, but could represent a significant impact on net energy savings. Since detailed load energy profiles were not available, net energy savings could vary depending on actual thermal and electrical use.

Table 5. Economic savings of fuel cell installation.

Case	ECF	TU	Displaced kWh	Displaced Gas (MBtu)	Electrical Savings	Thermal Savings	Nat. Gas Cost	Net Savings
Max. Thermal Case	90%	100%	1,576,800	7,358	$68,433	$15,893	$31,349	$52,977
Low Grade Heat Exchanger	90%	12%	1,576,800	899	$68,433	$1,885	$31,349	$38,969
High Grade Heat Exchanger	90%	31%	1,576,800	2,297	$68,433	$4,817	$31,349	$41,901

Assumptions:

Natural Gas Rate: $2.10/MBtu ($2.16/MCF)

Electricity Rate: $4.34 cents/kWh

Fuel Cell Thermal Output: 700,000 Btu/hr

Fuel Cell Electrical Efficiency (HHV): 36%

Seasonal Boiler Efficiency: 75%

ECF = Fuel cell electric capacity factor

TU = Thermal utilization

3 Conclusions and Recommendations

This study concludes that Building 1003 at the Stennis Space Center represents a viable application for a 200 kW phosphoric acid fuel cell. Researchers identified two location options. Option 1 is to locate the fuel cell nearest the mechanical room where thermal and electrical interfaces are very close. Option 2 is to locate the fuel cell on the back side of the building, a location that would require longer but still reasonably close interfaces. Site personnel have indicated that it is unlikely that the requisite approval could be obtained for Option 1.

It is recommended that the fuel cell thermal output be interfaced with the hydronic space conditioning system. Either the low grade heat exchanger or the optional high grade heat exchanger should be interfaced. The low grade heat exchanger will only be adequate for reheating (6 months/year), but would also make a PC25B fuel cell viable. The high grade heat exchanger can be used for both space heating and space reheating for the full 12 months. Net savings of $38,969 were estimated for the low grade heat exchanger and $42,436 for the high grade heat exchanger option. The high grade heat exchanger would add an additional $3,467 per year in energy savings.

Site representatives have expressed the desire to have their chillers on back-up power. This would require that they identify a separate 200 kW isolated load. In discussions with ONSI, it was not clear that their fuel cell could handle the motor start of the chiller. If a viable isolated load were to be identified, then the grid-independent option would need to be ordered.

A security fence will be required for this installation.

Appendix: Fuel Cell Site Evaluation Form

Site Name: **Stennis Space Center**
Location: **Stennis Space Center, MS**
Contact: **Mr. Robert Heitzmann**

1. Electric Utility: **Mississippi Power Company** Rate Schedule:

2. Gas Utility: **United Gas** Rate Schedule: **Spot Market**

3. Available Fuels: **Natural Gas** Capacity Rate:

4. Hours of Use and Percent Occupied:

Weekdays	**5**	**Hrs**	**12**	**%**
Saturday	**0**	**Hrs.**	**0**	**%**
Sunday	**0**	**Hrs.**	**0**	**%**

5. Outdoor Temperature Range:
   Winter Design Temperature: 22 °F
   Summer Design Temperature: 92 °F

6. Environmental Issues: **None.**

7. Backup Power Need/Requirement: **No backup power currently on building 1003. Navy strongly desires to have backup power capability on this building.**

8. Utility Interconnect/Power Quality Issues:
   Power quality is an issue for computer systems in the building
   Easy access to existing electrical panels
   Existing gas line into mechanical room

9. On-site Personnel Capabilities: **Boiler plant personnel**

10. Access for Fuel Cell Installation: **The first choice for the fuel cell location is the grass area in front of the entrance to the mechanical and electrical rooms. This area has been identified as the location for mechanical equipment required for a building addition on building 1000. The second choice is to place the fuel cell on the back side of the building 1003 and run interface piping and conduit above the ceiling space of the building.**

11. Daily Load Profile Availability: **Monthly values for building electrical and natural gas consumption were provided. The only gas use in the building is the boiler.**

12. Security: **A security fence will be required. Base personnel stated that a chain link fence would be acceptable.**

Site Layout

Facility Type: **Naval Oceanographic Office (Building 1003) Labs, Computer Operations and a Library**

Age: **Constructed 1983**

Construction: **Steel frame with Drivit exterior**

Square Ft: **64,287 sq ft**

See Figure 2

Show: electrical/thermal/gas/water interfaces and length of runs
drainage
building/fuel cell site dimensions
ground obstructions

Electrical System

Service Rating: **13.8 kVA 3 phase/ 4 wire**

Electrically Sensitive Equipment: **Computers**

Largest Motors (hp, usage):
Chillers
Chilled Water Pumps (qty=3)
Condenser Water Pumps
Cooling Tower Fans

Grid Independent Operation?: **Currently, there is no backup power for the facility. The Navy would like to have a backup power source for the facility.**

Steam/Hot Water System

Description: **Hot water boiler for space heating and reheat; Individual electric water heaters for domestic hot water in lavatories**

System Specifications: **Central Boiler: 1.440 MBH**

Fuel Type: **Natural Gas**

Max Fuel Rate:

Storage Capacity/Type: **Instantaneous Boiler**

Interface Pipe Size/Description:
4-in. diameter pipe.
System originally had heat recovery off chiller condensers but has since been abandoned

End Use Description/Profile: **Monthly gas consumption provided for central boiler. Consumption year round for space heating in winter and reheat in the summer.**

Space Cooling System

Description: **Central chilled water plant with distributed air handlers. The air handlers are configured for humidity control by means of cool reheat. Although the occupancy of the building is typically weekdays from 6:30 am - 5:00 pm, the space conditioning requirements are over a 24 hour period.**

Air Conditioning Configuration:

Chiller #1
Type: **Centrifugal**
Rating: **150 tons**
Make/Model: **McQuay Model #: PEH048-BAAA**

Chiller #2
Type: **Centrifugal**
Rating: **150 tons**
Make/Model: **McQuay Model #: PEH048-BAAA**

Seasonality Profile:
Typical months of cooling are April through October

Space Heating System

Description: **Instantaneous hot water boiler**

Fuel: **Natural Gas**

Rating: **1,440 MBH, 43 HP**

Water supply Temp: **130 °F – 180 °F controlled on outdoor temperature**

Water Return Temp: **Maximum temperature differential is 8 °F**

Make/Model: **Kewanee Boiler Corp. Model # 3R10-KG**

Thermal Storage (space?): **Only near proposed location of fuel cell at back of the building**

Seasonality Profile: **Space heating generally required from November through March. Reheating used throughout the year to maintain humidity levels in the labs.**

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14. ABSTRACT

Fuel cells are an environmentally clean, quiet, and a highly efficient method for generating electricity and heat from natural gas and other fuels. Researchers at the U.S. Army Construction Engineering Research Laboratory (CERL) have actively participated in the development and application of advanced fuel cell technology since fiscal year 1993 (FY93). They have selected and evaluated application sites, supervised the design and installation of fuel cells, actively monitored the operation and maintenance of fuel cells, and compiled "lessons learned" for feedback to the manufacturer for commercially available fuel cell power plants installed at Department of Defense (DOD) locations.

This report presents an overview of the information collected at the Naval Oceanographic Office, John C. Stennis Space Center, MS, along with a conceptual fuel cell installation layout and description of potential benefits the technology can provide at that location. Similar summaries of the site evaluation surveys for the remaining sites where CERL has managed and continues to monitor fuel cell installation and operation are available in the companion volumes to this report.

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